R E P O R T  R E S U M E S

ED 017 448 SE 003 050

INSTRUCTIONAL GUIDE FOR ELECTRICITY, JUNIOR HIGH SCHOOL INDUSTRIAL ARTS.

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REPORT NUMBER SC-627 PUB DATE 67
EDRS PRICE MF-$0.50 HC-$3.48 85P.

DESCRIPTORS- *ELECTRICITY, *INDUSTRIAL ARTS, *SECONDARY SCHOOL SCIENCE, *TEACHING GUIDES, *SCIENCE ACTIVITIES, SAFETY, TEACHING TECHNIQUES, LOS ANGELES CITY SCHOOLS, CALIFORNIA,

THIS GUIDE IS DESIGNED TO PROVIDE A PRACTICAL REFERENCE FOR TEACHERS PLANNING INSTRUCTION CONCERNING ELECTRICITY IN JUNIOR HIGH SCHOOL INDUSTRIAL ARTS CLASSES. THE GUIDE IS FOR A 10-WEEK COURSE DESIGNED TO PROVIDE THE STUDENT WITH EXPLORATORY EXPERIENCES INVOLVING THE BASIC PRINCIPLES AND APPLICATIONS OF ELECTRICITY AND ELECTRONICS. THE PROPER USE OF APPROPRIATE TOOLS, MATERIALS, AND EQUIPMENT IS DESCRIBED. PROJECTS AND EXPERIMENTS INCLUDE (1) SOURCES OF ELECTRICITY, (2) TRANSMISSION AND CONTROL, (3) COMMUNICATIONS, (4) MEASUREMENT, (5) CONVERSIONS, AND (6) SHOP PRACTICE. A SAFETY GUIDE FOR THE JUNIOR HIGH SCHOOL ELECTRICAL SHOP IS ALSO INCLUDED. (DH)

ED017448

# INSTRUCTIONAL GUIDE FOR ELECTRICITY

JUNIOR HIGH SCHOOL INDUSTRIAL ARTS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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LOS ANGELES CITY SCHOOLS
Division of Instructional Services
Publication No. SC-627
1967

SE003 050

# INSTRUCTIONAL GUIDE

# FOR

# ELECTRICITY

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## JUNIOR HIGH SCHOOL INDUSTRIAL ARTS

LOS ANGELES CITY SCHOOLS
Division of Instructional Services
Publication No. SC- 627
1967

This publication has been developed in accordance with the Comprehensive Curriculum Policy adopted by the Los Angeles City Board of Education.

APPROVED:

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# FOREWORD

The industrial arts electricity program in the Los Angeles City junior high schools centers pupil interest in electricity-electronics through study and practical applications. This program stresses the study of related technical information, general information, and occupational opportunities and requirements and provides for problem solving experimentation and construction of electrical devices. Safety practices in the use and handling of materials, tools, and equipment are emphasized as an essential part of the instruction.

This instructional guide provides practical help to the teacher in the selection, organization, and presentation of instructional units.

EVERETT CHAFFEE
Associate Superintendent
Division of Instructional Services

## ACKNOWLEDGMENTS

This publication has been revised by a committee of teachers, supervisors, and principals in conjunction with the Vocational and Practical Arts Section, Curriculum Branch. All teachers of junior high school electricity in the school system have had the opportunity to review the instructional content of the guide and to offer suggestions regarding it.

Grateful acknowledgment is extended to the following members of the curriculum committee, who initiated the development of the guide and were responsible for the implementation of the suggestions offered and for the organization of the instructional content.

| | |
|---|---|
| Joseph J. Ball | - - Airport Junior High School |
| Duane Christensen | - - Hughes Junior High School |
| L. Leroy Dooly | - - Irving Junior High School |
| James Downing, Jr. | - - Gompers Junior High School |
| Byron McKibben | - - Hale Junior High School |
| James Nicholson | - - Mark Twain Junior High School |

Sincere appreciation is extended to Fred A. Baer, supervisor of Industrial Arts, Division of Secondary Education, for his help and guidance in the revision of the publication.

Special acknowledgment is conveyed to J. HARVEY SEIPLE. Wright Junior High School, who, as a consultant in the Curriculum Branch, worked with the curriculum revision committee in organizing and compiling the content for this publication. Special acknowledgment also is conveyed to NORMANN LEFMANN, Industrial Education Consultant, Vocational and Practical Arts Section for the preparation of the final manuscript.

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## USE OF THE GUIDE

This instructional guide is designed to serve as a practical reference for the teachers in planning their day-to-day programs of instruction. The material originally was developed and has been periodically revised by teacher-supervisor committees and represents a city-wide instructional program which has been time tested in the Los Angeles City Schools. Teachers are expected to adapt this material and add other material as required by individual pupil and class needs. This instructional guide has value to new teacher and experienced teacher alike.

### Suggestions to the Teacher

1. Read the entire guide for an overall orientation of the publication.

2. Use the material listed in the Course of Instruction and safety sections as the basis for instruction. These materials should be considered as flexible suggestions, not restrictions.

3. Make notes on possible changes which may occur to you. A curriculum publication is only as good as its most recent revision. Suggestions should be forwarded to the Vocational and Practical Arts Section, Curriculum Branch, Division of Instructional Services, for consideration by the committee who undertakes the next revision.

# ELECTRICITY 1

Course No. 709*

Electricity 1 is a 10-week required course which is designed as an exploratory experience which introduces pupils to the basic principles and applications of electricity-electronics. Pupils receive the opportunity to use tools, materials, and equipment representative of the electronics field.

Instructional areas provided in this program are centered around pupil projects and experimentation, as applied to the principles of electricity, and include:

| | |
|---|---|
| Sources | Measurement |
| Transmission and control | Conversion |
| Communication | Shop practice |

Electricity 1 develops appreciation of good design and craftsmanship and provides opportunity to study occupational information related to opportunities and the requirments of the electrical and electronic industry.

Safety instruction is an integral and continuous part of the program. This course stresses the correct use and handling of tools and equipment.

## EXPLANATION OF BASIC AND ENRICHMENT INSTRUCTIONAL UNITS

Certain instructional units listed throughout the publication under the page heading "Skills, Processes, Activities" are marked by an asterisk (*). This symbol indicates that the unit so designated is to be included in the minimum program expected at the Electricity 1 level. The instructional units which are listed under the page headings "Related Technical Information" and "General Information" are considered essential when they are directly related to such a "marked" skill, process, or activity. Instructional units which are not so marked constitute enrichment units that may be utilized in the instructional program for the more able pupils.

*Catalog of Authorized Subjects, Junior and Senior High Schools (1965 Revision. Los Angeles City Schools: Division of Instructional Services, Publication No. SC-486).

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SOURCES OF ELECTRICITY

**Note:** The Electron Theory is common to most instructional units and should be applied to each instructional unit, when appropriate.

### Friction

| | |
|---|---|
| Generation of static electricity | Use a comb to generate a static charge (negative) |
| Protection form static charges | Use a glass rod to generate static charge (positive) |

### Batteries

| | |
|---|---|
| *Basic principles of the electron theory | *Check a battery with a voltmeter |
| *Polarity of battery cells | Replace cells, observing polarity in a flashlight, radio, or other device |
| *Types and uses of Primary cells | *Make a simple cell (Show construction of a D cell) |
| *Types and uses of Secondary cells | Make a secondary cell (Show model of car battery) |
| Construction of batteries | *Connect battery cells in series, and measure voltage |
| *Connection of cells in series | |
| *Connection of cells in parallel | Measure voltage of battery cells connected in parallel |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Use of devices to eliminate static charges (ground chains, lightning arresters, grounded auto seat covers, grounded kites, ....) | |
| Importance of correct battery polarity in relation to prevention of damage to electrical equipment | |
| Corrosion damage to electronic equipment from "dead" cells | |
| Use of battery cells in powering radios, tape recorders, test instruments and other electrical devices | |
| Care and safe handling of storage batteries | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **SOURCES OF ELECTRICITY (Continued)** | |
| **Generators, AC and DC** | |
| *Principles of magnetism | *Demonstrate AC and DC generators |
| *Identification of magnetic and non-magnetic materials | *Test a variety of metals for magnetic attraction |
| *Identification of magnetic fields | *Show magnetic fields around permanent magnet with use of iron filings |
| *Types and uses of permanent magnets and electromagnets | *Demonstrate permanent and electro-magnets |
| *Generation of electricity by induction | *Demonstrate current generation by induction (coil, magnet, and galvanometer) |
| Frequency of the current produced in a generator | Show frequency of current by moving a bar magnet in and out of the coil |
| **Piezoelectric Generator** | |
| Principle of operation of<br>...phonograph cartridge<br>...crystal microphone | Measure the outputs of a phono cartridge and a crystal microphone |
| **Photoelectric Generators** | |
| Principle operation of solar cells | Operate a small motor or other small device with power from solar cells |
| **Thermoelectric Generator** | |
| Principle of operation of<br>...thermopile<br>...fuel cells<br>...heat cells | Demonstrate generation of electricity with iron and copper coupling, heat, and galvanometer |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Generation of electricity for home and industrial use

Steam-powered and water-powered generators

Contributions of Michael Faraday

Use of permanent and electro-magnets in the home

Use of permanent and electro-magnets in industry.

Use of alternators on automotive engines

Types and uses of "hi-fi" amplifiers and tape recorders

Use of photoelectric components and circuits on space vehicles

Use of thermopiles as safety devices on gas-burning equipment

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **MEASUREMENT OF ELECTRICITY** | |
| **Meters** | |
| Types and uses of meters | |
| Units of electrical measurement: volt, ampere, watt, ohm, . . . . . | Measure voltage and current |
| **TRANSMISSION AND CONTROL OF ELECTRICITY** | |
| *Properties of insulators and conductors | *Test and identify material as insulators or conductors |
| *Uses of alternating and direct current in the home and industry | |
| *Types and uses of transformers | *Use transformers to increase or decrease voltage |
| *Use of overload protective devices in electrical circuits | *Demonstrate use of fuses |
| | *Discuss electrical safety and first aid for shock (25-110 volts can kill) |
| *Elements of a simple circuit | Connect cells, buzzer, and key in a simple circuit |
| | Wire a lamp |
| *Types and uses of continuity tests | Make continuity test, using ohm meter or continuity checker |
| Types and uses of etched circuit boards | *Etch a sample circuit board |
| *Identification of electric and electronic symbols | Mount and solder component parts to an etched circuit board |
| | *Construct a continuity tester |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Use of meters in radio and TV servicing | |
| Voltage and current ratings of home appliances | |
| Transmission and distribution of electricity, from source to consumer | |
| Types and uses of transformers in the home | |
| Use of fuses and circuit breakers in the home and car, and in electronic equipment | |
| Kite safety; dangers in handling electric appliances (See Safety) | |
| Wiring in the home and the car | |
| Use of low voltage outdoor lighting equipment | |
| Continuity tests for home appliances | |
| Commercial applications of etched circuit boards | |
| Control circuits and devices for the home | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **TRANSMISSION AND CONTROL OF ELECTRICITY (Continued)** | |
| *Elements of switching circuits<br>...use of resistance to reduce voltage<br>...use of amplifiers to increase voltage | *Control lamps with switches<br>Use resistance to dim a lamp<br>Use an amplifier to increase the weak output of a microphone<br>Construct a switch (key) |
| **CONVERSION OF ELECTRICITY** | |
| Motion | |
| *Principles of magnetism, as applied to motors<br>Types and uses of solenoids and relays | *Demonstrate how a motor works (attraction and repulsion)<br>Show operation of relays and solenoids<br>Construct magnetic devices (motor, buzzer, .....) |
| Light and Heat | |
| *Principles of light and heat<br>*Types and uses of electric lights (incandescent, flourescent, and gas-filled lamps) | *Make simple heat and light experiments<br>...Connect short length of resistance wire to a variable transformer<br>...Note the change in light and heat as voltage is increased<br>Connect a 100-watt lamp to a power source (Note the heat generated) |
| Principle of electric welding | Spot weld pieces of sheet metal together |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Types and uses of switches (toggle, slide, rotary - SPST, DPDT,.....) | |
| Uses of resistors in the home | |
| Uses of amplifiers in the home and industry | |
| Uses of motors in the home and in the industry | |
| Noted men who have made contributions to the field of electrical science | |
| Electrical heating, in home and industry | |
| Development of electric lamps, from the days of Edison to the present | |
| Electrical welding in industrial production and assembly | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **CONVERSION OF ELECTRICITY (Continued)** | |
| **Sound** | |
| *Production of vibration by magnetic force | *Use a wire buzzer to produce vibration by magnetism |
| *Production of vibration by piezo-electric effect | *Observe the action of a speaker cone and feel the diaphragm of a magnetic earphone in operation |
| **Chemical Action** | |
| Basic principle of electroplating | Electroplate copper to another metal |
| **Alternating Current to Direct Current** | |
| Basic principles or rectification | *Use a transformer and rectifier to produce DC and AC<br><br>Show battery eliminator and power supplies |
| **COMMUNICATION** | |
| *Types and uses of AM radio receivers | *Construct a crystal set |
| Amateur radio communications and Federal Communications Commission regulations | Make block diagrams of a radio receiver |
| Citizen band communications and Federal Communications Commission regulations | Discuss amateur and CB operator's licenses |
| Basic principles of<br>...laser<br>...satellite | Construct simple transistorized projects: code oscillator, amplifier, radio,..... |
| Basic principles of television | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Home installation and maintenance of bells, chimes, and buzzers | |
| Types and uses of speakers and earphones | |
| Protection of metal surfaces by electroplating | |
| Battery chargers, eliminators, power supplies, radios and television receivers, amplifiers, and electronic equipment | |
| Brief history of the development of radio receivers, from crystal sets to transistorized receivers | |
| Use of tuned circuits in radio receivers and transmitters | |
| Federal Communications Commission rules and method of regulation | |
| Use and importance of semiconductors | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **SHOP PRACTICE** | |
| *Application of drafting principles and techniques | Follow oral and written instructions |
| | Plan a sequence for doing a job |
| | Make a dimensioned sketch |
| | Make a working drawing |
| | Make a list of materials |
| *Physical and electrical characteristics of materials | *Select proper insulating and conducting materials |
| *Knowledge of electrical symbols | *Make a schematic drawing of a project circuit, using standard electronic symbols |
| *Importance of accuracy | Make measurements to the nearest 1/32 of an inch |
| | Check squareness of project with a try square |
| | Lay out a project base, using a try square and pencil |
| Use of drill and wire gauges | Measure twist drills and wire, using the proper gauge |
| | Lay out a design for simple circuit board |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
| --- | --- |
| Value of planning as compared with trial-and-error methods (savings of time and material) | |
| Value of drawings and pictures in conveying a clearer understanding | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| | **SHOP PRACTICE (Continued)** |
| **Cutting** | |
| Scientific principles involved in cutting tools (plane, chisel, twist drill, tin snips, . . . . . ) | Use hand saw to cut stock |
| | *Use miter box to make square cuts |
| | Use block plane to true wood surface |
| *Types of hacksaw blades | *Use hacksaw to cut a rod or bar stock |
| *Selection of proper hacksaw blade | |
| | *Use pliers to cut wire |
| | *Use tin snips to cut sheet metal |
| Material strength: its resistance to cutting in relation to tool breakage | *Use a file to remove material |
| | File to a line |
| Methods of cleaning files | *Clean a file |
| | Punch small holes in sheet metal using a lever punch |
| Types and uses of buffing wheels and compounds | Buff metal or plastic parts |
| **Drilling** | |
| Types and uses of auger bits | Use brace and bit to bore holes in wood |
| Types and uses of twist drills | |
| | *Center punch to locate holes |
| Use and care of power tools | Drill holes in material, using drills and bits with the drill press<br>. . . twist drills (wood, metal, plastic)<br>. . . power bit (wood, plastic) |
| Types and uses of countersinks and counterbores | Drill holes, using a twist drill in a hand drill |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Consideration of direction of grain in cutting wood

Safety in the use of cutting tools

Drilling jigs and fixtures used in industry to save time and to increase accuracy

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **SHOP PRACTICE (Continued)** | |
| **Drilling (Continued)** | |
| Importance of holding materials properly while drilling | *Use holding devices (drill vise, hand, vise grip pliers, C-clamp, fixtures) while drilling materials with a drill press |
| *Variation of speed through the use of belts and pulleys | |
| *Variation of appropriate drill speed in relation to drill sizes | Clean and oil hand tools |
| Types and uses of power bits | |
| **Threading** | |
| Use of tap and drill tables | Cut internal threads in material using tap |
| *Types and uses of machine screws and other fasteners | Cut external threads on stock, using die |
| **Forming** | |
| Properties of materials (hardness softness, resistance to oxidation,. . . . .) | *Bend wire, rod, and band iron, using<br>. . . vise and hammer<br>. . . pliers<br>. . . bending jig |
| Ways of preventing damage to material while held in vise | |
| Uses of bending jigs (save time, increase accuracy, make duplications, . . . . . ) | Use box and pan brake to bend sheet metal |
| Use of lubricants in cutting threads | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Selection, purchase, and care of
home workshop tools and equipment

Industry's uses of
- . . . multiple spindle drill
- . . . gang drill
- . . . radial drill press

Application of metal threads to
everyday life (garden hose, auto
parts, appliance parts, fasteners, . . . . . )

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **SHOP PRACTICE (Continued)** | |
| **Fabrication** | |
| Types and specifications of hardware | Assemble project, using nails, wood and sheet metal or machine screws |
| Types and uses of fasteners | |
| Care of soldering equipment | Light a soldering furnace |
| Preparation of material surface for soldering | Clean and tin the tip of soldering copper |
| Type of solder | Prepare material surfaces by cleaning with abrasive or steel wool |
| *Insulation removed in relation to wire damage | *Solder, using soldering copper or electric soldering gun on sheet metal, wire, and circuit boards |
| *Types and uses of fluxes<br>. . . electrical wiring<br>. . . sheet metal work | *Remove insulation from wire, using knife or strippers |
| Heat conductivity of metals in relation to overheating of electronic components | |
| Relation of cold solder joints to improper operation of electrical circuits | Join wire, using an appropriate splice |
| | Solder and tape splices and terminals |
| **Finishing** | |
| Types and uses of abrasive papers and cloths | Use abrasives to prepare a surface |
| Types and uses of wood and metal finishes | *Finish wood and plastic surfaces with sandpaper |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Sources of tin | |
| General applications and importance of soldering (sheet metal containers, gas meters, gauges, electronics production, auto bodies, . . . . . ) | |
| Danger of burns or fire through improper handling of soldering devices | |
| Reasons for, results of, and prevention of deterioration of metal finishes | |
| Types of abrasives used in household repairs and maintenance | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SHOP PRACTICE (Continued)

### Finishing (Continued)

| | |
|---|---|
| *Types and uses of thinners and solvents | *Emery cloth metal surfaces |
| | Buff metal and plastic parts |
| | Apply protective coatings brush application (spray application from pressurized cans) |
| *Types, uses and care of paint brushes | Clean paint brushes |
| Use, care and disposal of pressurized paint cans | |
| Application of etched finishes on metal | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Care, storage, and disposal of finishing materials | |
| Ways of painting and refinishing metal items used in the home | |
| Advantages and uses of plated and anodized metal surfaces and the maintenance of them | |

## ELECTRICITY 2, 3, 4

**Course Nos. 710, 711, 712***

Electricity 2, 3, and 4 are offered as one-semester elective industrial arts courses. They offer pupils additional opportunities to discover further interest and develop further abilities in the electricity-electronics field.

These courses emphasize new skills and more advanced contemporary experiences as they apply to the principles of electricity. Skillful and knowledgable use of tools and equipment is stressed continually in the daily activities of pupils.

Functional applications of language, science and mathematics are emphasized and are applied to practical projects. Project construction and experimentation occupy the major part of the pupil's time, the balance of which is spent in demonstrations, class discussions, reading assignments, and reports.

Pupil projects and experimentations are centered around principles of electricity, including:

| | |
|---|---|
| Sources | Conversion |
| Measurement | Communication |
| Transmission and control | Shop practice |

### EXPLANATION OF BASIC AND ENRICHMENT INSTRUCTIONAL UNITS

Certain instructional units listed throughout the publication under the page heading "Skills, Processes, Activities" are marked by an asterisk (*). This symbol indicates that the unit so designated is to be included in the minimum program expected at the Electricity 2 level. The instructional units which are listed under the page headings "Related Technical Information" and "General Information" are considered essential when they are directly related to a "marked" skill, process, or activity. The minimum instructional units similarly marked for Electricity 1 are to be reviewed and re-emphasized.

The minimum instructional units, marked (*) for the Electricity 1 and 2 programs, are to be reviewed and re-emphasized in Electricity 3 and 4 as a basis for the development of reasonable understanding and successful achievement in these advanced programs. The "unmarked" instructional units in the following material are a part of the minimum program for Electricity 3 and 4. Teachers are encouraged to add material that will implement and supplement the teaching of this suggested program, as need is indicated by pupil ability and interest.

*Catalog of Authorized Subjects, Junior and Senior High Schools (1965 Revision. Los Angeles City Schools: Division of Instructional Services, Publication No. SC-486).

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SOURCES OF ELECTRICITY

**Note:** The Electron Theory is common to most instructional units and should be applied to each instructional unit, where appropriate.

| | |
|---|---|
| **Friction** | |
| *Electron theory | |
| *Protection form static charges | Observe the static charge that is generated when you slide across a car seat and touch metal |
| **Batteries** | |
| *Basic principles of the electron theory | |
| | *Check cell polarity with voltmeter |
| *Polarity of cells | |
| | Replace cells in a flash light or radio |
| Chemical action in cells | |
| *Definitions of voltage and current | |
| *Types and uses of primary cells | Make a simple cell to review polarity and chemistry |
| *Types and uses of secondary cells | Make a secondary cell to review the chemistry |
| *Connection of cells in series | *Connect two or more cells in series and measure the voltage and amperage with appropriate load |
| *Connection of cells in parallel | *Connect two cells in parallel and measure the voltage and amperage |
| *Connection of cells in series-parallel | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Industrial uses of static electricity (smoke control, manufacture of sandpaper, .....) | |
| Manufacture and uses of dry cells (sizes, ratings, rechargeable cells) | |
| Manufacture and uses of secondary cells | |
| Battery cell life and voltage<br>...parallel hookup<br>...series hookup<br>...series-parallel hookup | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| SOURCES OF ELECTRICITY (Continued) | |
| Generators, AC and DC | |
| *Principles of magnetism | |
| *Magnetic and non-magnetic materials | *Test the magnetic properties of different materials |
| Permanent magnets and electro-magnets | *Demonstrate permanent magnets and electromagnets |
| *Magnetic fields | *Show magnetic fields with compass and iron filings on paper |
| *Induced electromotive force | *Show by use of magnet, coil, and galvanometer |
| *Definitions of cycle and amplitude in relation to alternating current | Observe the wave pattern of alternating current on oscilloscope |
| *Comparison of AC and DC generators | Observe the teacher demonstrate generators |
| Commutation and slip rings | . . . DC motor<br>. . . slot car motors |
| Permeability of core materials | . . . coil wire, permanent magnets and galvanometer |
| Tape recorder (in playback) | Examine the construction of the recording head of a tape recorder |
| Piezoelectric Generator | |
| *Care and operation of<br>. . . phonograph cartridge<br>. . . crystal microphone | Use a VTVM to measure the outputs of a phono cartridge and a crystal microphone |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Community service or public utility companies | Field Trips<br>. . . Generating plants (steam)<br>. . . Substations (electrical)<br>. . . Electronic manufacturing companies |
| Generation of electricity in hydro-electric and steam generation plants | |
| Use of automotive generators and alternators | Guest Speakers<br>. . . Local businessmen<br>. . . Southern California Edison representatives<br>. . . Los Angeles Department of Water and Power representatives |
| Dynamic microphones and reluctance type phonograph pickups | |
| Composition and manufacture of recording tape | |
| Commercial applications of crystals | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SOURCES OF ELECTRICITY (Continued)

### Piezoelectric Generator (Continued)

Factors negatively affecting piezoelectric generators (temperature, mechanical shock, . . . . . )

### Photoelectric Generator

*Care and operation of
- . . . solar cells
- . . . photo tubes
- . . . photo cells

### Thermocouple Generator

*Thermopile

Measure the output of a thermocouple

Measurement of temperature

Fuel, pile, and heat cells

Direct conversion of fuel to electrical energy

## MEASUREMENT OF ELECTRICITY

### Direct Current

*Units of measurement: volt, ohm, ampere, watt

Demonstrate meter movement using meter mounted in plastic case

Use, care, and construction of DC meters
- . . . voltmeter
- . . . ammeter
- . . . ohmmeter

Measure the voltage of several cells in series

Measure current, using an appropriate resistor as a load

Measure an appropriate resistor using ohmmeter

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Use of solar cells to generate DC to operate and charge batteries in space vehicles and telephone installations | |
| Use of thermocouples on automatic gas-burning equipment | |
| Use of pyrometers for the measuring of temperature in furnaces, and jet and rocket engines | |
| Research in the production of electrical power by means of fuel cells | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **MEASUREMENT OF ELECTRICITY (Continued)** | |
| Direct Current (Continued) | |
| Types of meter movements | |
| *Meaning of instrument sensitivity (ohms per volt) | *Measure the voltage across a high resistance and notice the difference when meters of significantly different ohms per volt sensitivity are used |
| Multimeters | |
| Vacuum tube volt meters (transistor version) | |
| Alternating Current | |
| *Use, care, and construction of AC meters | *Frequency limitations of both AC multimeters and vacuum tube voltmeters |
| *RMS and peak voltage | Measure the unknown of an electrical source |
| Theory of basic operation of an oscilloscope | Use oscilloscope to measure voltage and wave frequency |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Quality control in relation to the manufacture of precision measuring devices

Limitations of some electrical meters for measuring high resistance
- . . . multimeters or volt-ohm-milliameter
- . . . vacuum tube voltmeters

Commercial and military uses of oscilloscopes

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## TRANSMISSION AND CONTROL OF ELECTRICITY

### Power Distribution

| | |
|---|---|
| *Efficiency of high-voltage distribution systems | |
| Uses of single phase and three-phase electrical power | |
| *Types and uses of conductors | *Test materials for conductivity |
| Wire size and material in relation to<br>. . . current-carrying capacity of wires<br>. . . continuity testing<br>. . . overload protection | Use wire tables to determine current capacity of wires<br><br>Install a fuse in a circuit |
| | *Test materials for voltage breakdown |
| *Types and uses of insulators | |
| Types and uses of insulation | |
| Need for care in handling electrical equipment | |
| Types and uses of transformers (power, audio and radio frequency, ignition, . . . . . ) | Demonstrate repulsion coil<br><br>Construct a simple transformer |
| Principles of inductance (core, coil size, spacing, and turns ratio) | Find the turns ratio from the primary and secondary voltages of a transformer |
| Effect of frequency and core material (audio and radio frequency applications) | Demonstrate the increase of voltage, using neon transformer or auto ignition coil |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Transmission of electrical power from source to consumer (use of voltage transformers, conductors, and insulators)

General provisions of electrical codes and regulations (City Building Code, and Underwriters' Standards, County Code)

Manufacture of wire and insulating materials (aerial, underground, telephone, submarine, high-voltage cables, . . . . .)

Uses of fuses and breakers

Potential danger from high voltage in television receivers

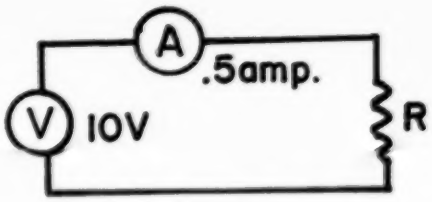
Types and sizes of wire (aerial, underground, telephone, high-voltage, ignition, hookup, . . . . .)

Relation of voltage and amperage to transformer input and output

Application of "turns ratio" to transformer design and utilization

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **TRANSMISSION AND CONTROL OF ELECTRICITY (Continued)** | |
| Power Distribution (Continued) | |
| Permeability of transformer core materials (air, ferrite, silicon, steel, and permalloy) | *Test the continuity of the windings of an unknown transformer, using an ohmmeter |
| | Identify the primary and secondary windings of a transformer |
| | *Test an unknown transformer, using a signal voltage and an AC voltmeter |
| Basic Circuits and Control Devices | |
| *Elements of basic circuits (load, source, control device and wiring) | Make drawing of circuits to control a lamp from one, two, and three positions |
| Identification and uses of electric and electronic symbols | |
| *Types and uses of manual switches (toggle, slide, rotary, SPST, DPTT, .....) | |
| *Types and uses of magnetic switches | Connect relays and solenoids to control circuits |
| *Operation of electronic controls | |
| Types and uses of amplifiers | Make a schematic drawing of one tube or one transistor amplifier |
| *Electron theory, as applied to vacuum tubes semiconductors, and transistors | Use the vacuum tube and transistor characteristic manual as reference source |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Types of transformers: auto, isolation, variable, electronic, neon, and auto ignition | |
| Operation of auto ignition systems (including transistorized systems) | |
| Basic home and car wiring | |
| Use of low-voltage light switching systems in the home | |
| Commercial uses of amplifiers | |
| Development of electron tubes, since the days of De Forest | |
| Manufacture of tubes and transistors | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **TRANSMISSION AND CONTROL OF ELECTRICITY (Continued)** | |
| Basic Circuits and Control Devices (Continued) | |
| Use of heat sinks in the dissipation of heat | Test vacuum tubes and transistors (Show how the output varies with grid or base voltage change. Trace electron flow in an amplifier circuit) |
| Discovery and development of semiconductors and transistors, in relation to their use in replacing vacuum tubes | Design and etch a circuit board for a small amplifier or radio receiver |
| Use of miniaturization, modules, and circuit boards | Mount and solder electronic components to a circuit board for a small amplifier or radio receiver |
| Types and uses of photoelectric cells | Demonstrate applications of the photo cell and a beam of light |
| *Use of identification color codes | Use color code to identify the value of a resistor |
| *Use of Ohm's Law | Use an ohmmeter to measure the value of a resistor |
| Use of basic formulas, such as E = IR | Example:   |
| How to measure and calculate resistors connected in series | Find the value of R |
| Meaning of impedance | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Types of switches and outlets used in 110 V. A. C. circuits | |
| Types of switches and outlets used in 110V AC circuits | |
| Control of automatic lighting in home and industry | |
| Use of photocells in opening and closing devices, (burglar alarms, . . . . .) | |
| Heat losses in resistors | |
| Effects of frequency and core materials (60 cycle, audio and radio frequencies | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

TRANSMISSION AND CONTROL OF ELECTRICITY (Continued)

Basic Circuits and Control Devices (Continued)

Use of basic formulas, such as $P = IE = I^2R$

Use the formula to find the value of an unknown factor

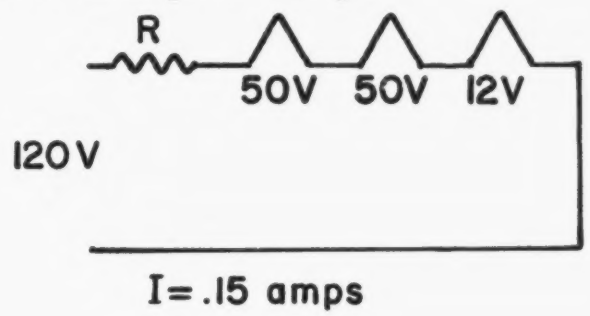
Rating and physical size of resistors (carbon and wire wound)

*Use of resistance in series

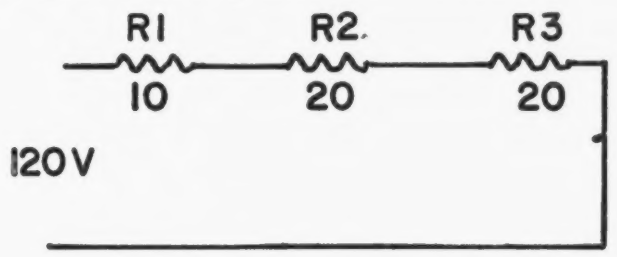
Lamps, tubes, and resistors in series

$R = \frac{E}{I} = \frac{8}{.15} = 53$ ohms

*Use the tube manual to find voltage and current ratings of vacuum tubes and pilot lamps




Find the total resistance of heaters in series using and ohmmeter




$R_t = R_1 + R_2 + R_3$

$R_t = 10 + 20 + 20 = 50$ ohms

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Theory of vacuum tube operation | |
| Identification and operation of tube parts (heater, cathode, control grid, screen grid, suppressor, grid, and plate) | |
| Uses of resistance in electrical devices used in the home | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## TRANSMISSION AND CONTROL OF ELECTRICITY (Continued)

### Basic Circuits and Control Devices (Continued)

*Use of resistance in parallel

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{10} + \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{R_t} = \frac{4}{20} \qquad R_t = 5 \text{ ohms}$$

$$1 = \frac{10}{10} = 1 \text{ Amp} \qquad 1 = \frac{10}{20} = .5 \text{ Amps}$$

$$1 = \frac{10}{20} = .5 \text{ Amps}$$

Total current 2 Amps

Use of resistance in series-parallel

$$\frac{1}{R_t} = \frac{1}{40} + \frac{1}{20} + \frac{1}{40} + \frac{4}{40}$$

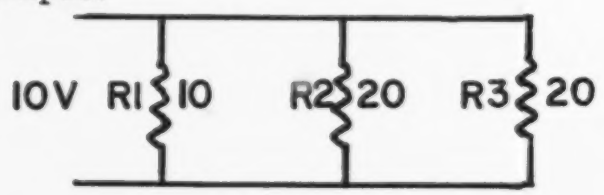
$$R_t = 10 \text{ ohms} \qquad I = \frac{10}{10} = 1 \text{ Amp}$$

$$I_1 = \frac{10}{40} = .25 \text{ Amps} \qquad I_2 = \frac{10}{20} = .5 \text{ Amps}$$

$$I_3 = \frac{10}{40} = .25 \text{ Amps}$$

Find the total resistance in a circuit. Find the current in a circuit, with voltage and resistance given

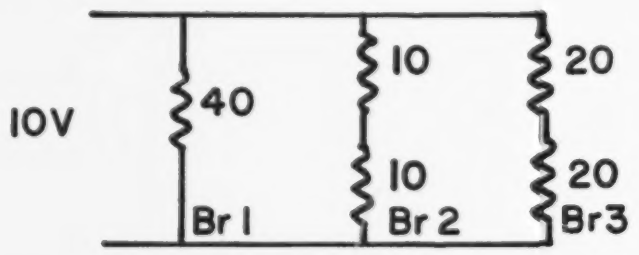
Example:




Find total current through current in each R

Find the total resistance in a parallel circuit and the current in each resistor

Example:




Compute total resistance in circuits. Compute current in branches of a circuit

Combine resistors in series-parallel to obtain desired value or wattage

**GENERAL INFORMATION** **INSTRUCTIONAL AIDS AND NOTES**

Applications of parallel circuits
in home and car wiring

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## CONVERSION OF ELECTRICITY

### Motion

| | |
|---|---|
| Motors | Construct a project involving a motor<br>. . . electric pencil<br>. . . buzzer<br>. . . solenoid switch |
| *Principles of magnetism in permanent and electromagnets | |
| *Types and uses of electric motors (DC, AC and universal, synchronous, capacitor, . . . . . ) | Demonstrate speed control of electric motors |
| *Commutation in electric motors | Make a list of automatic home appliances and list the uses found for solenoids and relays |
| Starting, reversing, and controlling electric motors | |
| Single-phase and three-phase systems | |
| *Types and uses of solenoids and relays | |

### Light and Heat

| | |
|---|---|
| *Principles of heat and light by electrical generation | *Connect a short length of resistance wire across a variable low-voltage transformer. Increase the voltage slowly and note the change in heat and light produced |
| *Types of electric lamps (incandescent gas-filled, fluorescent, . . . . . ) | Make a circuit drawing for a fluorescent lamp controlled by a switch |
| Television pictures | |
| Principles of Laser | |
| Principles of electric welding | Spot weld pieces of sheet metal together |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Use of motors in home and industry (models, Diesel trains, refrigerators, fans, . . . . .)

Home owner repair and maintenance of electric motors

Use of relays in capacitors and "electronic brains"

Relays and solenoids to control valves, circuits, and teletypes

Repair and maintenance of home appliances

Electrical heating in home and industry

Conversion of electricity to light

Improvements in lamps since the days of Edison

Types of street lighting (incandescent, arc, sodium and mercury vapor, . . . . .)

Uses of welding in commercial assembly work

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **CONVERSION OF ELECTRICITY (Continued)** | |
| Light and Heat (Continued) | |
| Heater wire and filament materials | |
| Sound | |
| *Use of magnetically produced vibration | Observe the movement of a speaker cone |
| *Use of piezoelectrically produced vibration | |
| Commercial uses of crystals (phono pickups, microphones, earphones, measurement of strain and stress in materials, ceramic crystals, ultrasonic cleaning, frequency control, . . . . .) | |
| Magnetic applications (speakers, earphone, buzzers, telephone, telegraph circuits, . . . . .) | |
| *Uses of carbon microphones | *Demonstrate the operation of a carbon microphone |
| Chemical Action | |
| Principles of electro-plating | |
| Kinds and uses of electro-plating | Observe a demonstration of copper plating. Electro-plate project parts, if plating equipment is avialable. |
| Transfer of metal ions | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Types of commercial plating
used in the manufacture of products

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## COMMUNICATIONS

### Power Supplies

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| *Types of half-wave and full-wave rectifiers | Make diagrams of power supplies |
| *Types and uses of filters | Use the oscilloscope to show the difference between output of half-wave and full-wave rectifiers |
| *Uses of voltage bleeders and dividers | Use the oscilloscope to show difference between pulsating DC and filtered DC |
| Use of vibrator to convert DC to AC (motor generator set, transistor oscillator, . . . . .) | *Use oscilloscope to make AC and DC voltage and current measurements |
| Conversion of low-voltage DC to high-voltage DC through transistor multivibrator circuit and power diodes | Demonstrate conversion of AC to DC |
| Methods of voltage regulation | Construct a simple power supply |
| Types and uses of vacuum tubes and diodes in rectifier circuits | |
| Types and uses of battery chargers and eliminators | |
| Power supplies for fixed and mobile electronic equipment | |
| Types and uses of capacitors: paper, oil-filled, or electrolytic (polarity) | |
| Types and uses of inductors (chokes) | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Bleeder resistors and cabinet
interlocks, (25 volts can be lethal)

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **COMMUNICATIONS (Continued)** | |
| **Power Supplies (Continued)** | |
| *Danger of high voltage (Short out high voltage before working on equipment) | |
| Audio and RF generators change DC to AC | Use audio generator to demonstrate frequency spectrum |
| Relationship of cycles, kilocycles, megacycles | |
| **Transmitters** | |
| *Tuned circuits | *Use a grid dip meter to check a tuned circuit of a transmitter |
| Principles of radio transmission and reception | *Use a phono oscillator to transmit a signal |
| *FCC regulations | |
| *How to become a radio amateur | Practice Morse code |
| Oscillators: crystal, variable | |
| Use of radio in air and sea navigation | |
| **Receivers** | |
| *Principles of radio detection | Make a diode radio receiver |
| Principles of tuned circuits | *Use a grid dip meter to check a tuned circuit of a receiver |
| Principles of resonance | *Wire simple electronic circuits using diodes and transistors |
| Principles of operation of semi-conductors | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Federal Communications Commission and the control of all communication media and frequency allocation (UHF, VHF, . . . . .)

Operation of equipment by remote control (garage doors, model planes, satelites, . . . . .)

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## COMMUNICATIONS (Continued)

Receivers (Continued)

*Types and uses of semiconductors

*Types of amplifiers (audio, RF, IF, .....)

Principles and operation of the radio compass

Types and uses of capacitors (mica, ceramic, disc, solid state, variable, trimmer, coupling, bypass, filter, .....)

Types and uses of coil stock

*Use a signal generator to service an amplifier or radio receiver

Use a portable radio as a direction finder (Rotate it for a null on different stations)

Make simple project, using an amplifier

## SHOP PRACTICE

Review and re-emphasize Skills and Processes listed under Electricity 1.
Review and re-emphasize Related and Technical Information listed under Electricity 1.

*Application of drafting principles and techniques

*Physical and electrical characteristics of materials (strength, conductivity, durability, .....)

Apply oral and written instructions to project planning

Draw a dimensional sketch of a job

Make a working drawing

Select materials to be used in a project

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Vocational opportunities for electronic technicians and engineers

Brief history of radio, from the days of Marconi to the present

Basic differences between amplitude modulation (AM) and frequency modulation (FM)

Increased use of semiconductors and transistors in electronic equipment (auto and portable radios, small TVs)

Basic trouble-shooting of electronic equipment

Saving time and material through planning in comparison with trial-and-error methods

Use of inspection and quality control procedures in industry

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

SHOP PRACTICE (Continued)

| | |
|---|---|
| *Use and identification of electronic symbols to express electrical concepts quickly and accurately | Plan a sequence for doing a job |
| | Make a schematic drawing, using electronic symbols |
| *Tolerances commonly used in industry | Make a list of materials |
| *Methods of measuring (rule, gauges, micrometer, comparator) | Lay out and measure material to one-sixteenth of an inch |
| *Comparison of fractional, letter and number drills | Measure the thickness of sheet metal, using micrometer |
| *Measurement of wire | Measure twist drills, using drill gauges |
| *Importance of accuracy | Use wire gauge to determine wire size |
| Use of a decimal equivalent chart | Measure the diameter of work turned in lathe with micrometer |
| | Lay out a chassis |
| | Lay out a design for a circuit board |
| | Lay out work with scribe and combination square (chassis, . . . . .) |
| | Use dividers to transfer measurements |
| | Lay out circles with dividers (chassis and panels) |
| | Center punch hole location with a center punch |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Uses of tube manuals and manufacturer's specifications | |
| Uses of wire tables to check diameter, area, turns per inch, feet per pound, resistance, and current carrying capacity | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|
| **SHOP PRACTICE (Continued)** | |
| **Cutting** | |
| Use of the proper hacksaw blade for the thickness and kind of material to be sawed | Cut tubing, heavy sheet, and other metal stock with hacksaw |
| | Cut metal stock, using bolt cutters |
| Scientific principles used in tool design: levers, gears, and the inclined plane | Punch holes in sheet metal |
| | Use squaring shear to cut sheet metal |
| Shearing action of the blade and lever action of the foot treadle on the squaring shear | Cut sheet metal with tin snips |
| Use of tap and drill charts | Select and use proper twist drills |
| Use and care of hand tools | Cut internal threads with tap |
| | Cut external threads with die |
| Types of files | File material to a line |
| | Finish metal by draw filing |
| Buffing wheels and compounds | Use nibbler to make small rectangular holes |
| | Clean file with a file card |
| **Drilling** | |
| Importance of drill rake and clearance in grinding | Grind a twist drill |
| Use of coolants in drilling | Enlarge holes, using a taper reamer |
| Proper selection of a file | |
| Properties of high speed drills | |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Material strength: its resistance to cutting in relation to tool breakage | |
| Use of the squaring shear in industry | |
| Reduction of friction by lubrication | |

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SHOP PRACTICE (Continued)

### Drilling (Continued)

| | |
|---|---|
| Relation of proper drill speed to drill size | Use a portable electric drill to drill holes |
| Variation of machine speed through the use of belts and gears | Drill holes, using hole saw and/or circle cutter in the drill press (under direct teacher supervision) |
| Importance of holding work securely while drilling or boring | Turn and drill metal to specifications in a lathe |
| Scientific principle of the rack and pinion gear (lathe and drill press) | |
| Importance of lubrication while drilling | |
| Use of threads to produce pressure in vises and clamps and to move the crossfeed of the lathe | |

### Grinding and Buffing

| | |
|---|---|
| Types and uses of grinding wheels | Sharpen a center punch |
| | Use grinder to remove mushroom head of tool |
| | Sharpen a twist drill |
| | Buff metal or plastic to improve the project appearance |

### Fabrication

| | |
|---|---|
| Properties of metals (in relation to bending, welding, soldering, finishing, . . . . .) | Make adjustments and set up and use box and pan brake to bend sheet metal to shape |

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|

Advantages and disadvantages in using the portable electric drill

Industrial soldering techniques and mass production of electronic equipment

| RELATED TECHNICAL INFORMATION | SKILLS, PROCESSES, ACTIVITIES |
|---|---|

## SHOP PRACTICE (Continued)

### Fabrication (Continued)

Types and uses of solder and fluxes

Principles of resistance welding

Heat conductivity of metal

Types and uses of adhesives
- . . . epoxies
- . . . glues

Use a heat sink to carry away heat from electronic parts while soldering

Spot weld sheet metal

Bend metal in a vise

Assemble units, using fasteners

### Finishing

Evaporation of solvents

Types and uses of solvents, thinners, and reducers

Need for ventilation during finishing operations

Principle of spontaneous combustion

Apply identification decals

Use of safety cans for storage of flammable liquids

Apply paint, using a pressurized can

Apply paint, using a brush

Finish material with abrasive paper or cloth

Finish material with steel wool, cloth and polishing agent

| GENERAL INFORMATION | INSTRUCTIONAL AIDS AND NOTES |
|---|---|
| Spot welding in industrial assembly | |
| Care, storage, and disposal of pressurized paint cans | |
| Care and storage of finishing materials | |
| Disposal of paint rags | |
| Fire hazards in the use of finishing materials | |

# SAFETY

Safety precautions which are listed in this section must be included in the continuous safety program conducted in electricity.*

Because the following safety precautions may not cover all of the possible hazards in the junior high school electric shop, additional precautions should be developed by the individual teacher to cover special safety problems unique to his class activity, such as those which may be related to shop layout, class size, and processes in the use of machines, tools, equipment, and materials.

The following safety precautions and regulations are to be used as topics for "shop talks" and discussions at the time instruction is given in the use of hand tools, machines, materials, and equipment.

*See Safety Manual for Industrial Education. (Los Angeles City Schools: Division of Instructional Services, Publication No. SC-601), for a complete listing of safety rules and regulations which must be observed in the shops of the Los Angeles City Schools.

GENERAL SAFETY

1. Face shield or goggles must be worn by shop pupils when there is any possibility of eye injury. The teacher is responsible for designating shop activities and areas that are hazardous.

2. Explain the practice earthquake, fire, and disaster drill periodically.

3. Report any injury, no matter how slight, to the teacher immediately. Infection may result from uncared for minor cuts and scratches.

4. Observe all rules of safe conduct, whether they were initiated by your classmates or by the school authorities. Generally, rules facilitate effective, wholesome, and safe operation and are in the best interest of all persons concerned.

5. Always stop, look, and <u>think</u> before you proceed into a dangerous or unfamiliar situation.

6 Notify the teacher if you notice any unsafe conditions in the shop or any violation of the safety rules. Because such reporting may prevent serious injury, it should not be considered "snitching."

7. Secure the permission of the teacher before you begin any job. He may make suggestions that will prevent an accident.

8. You are <u>not permitted</u> to work any machine or equipment before, during, or after class hours, without permission and unless the teacher is nearby to provide immediate assistance.

9. You must pass the required safety test before you are allowed to work in the shop.

10. To avoid injury, keep your attention focused on your work.

11. Block off any unguarded area which is dangerous, such as the location of spilled material on the floor, and report the condition to the teacher.

12. Remember that playing or scuffling, sometimes referred to as "horse-play," is extremely dangerous and that personal injury often occurs. A playful push may result in a bad cut from contact with the sharp edge of a bench or the corner of a machine.

13. <u>Never run in the shop.</u> You may injure yourself or other persons.

14. Do not throw objects in the shop. Someone might be seriously injured.

15. Wear proper shoes. Shoes which have worn soles are dangerous, especially, if the wearer steps on a sharp object.

16. In the event of fire, report it immediately to the teacher. He will determine what action to take.

17. Know the location and correct use of the fire blanket and what to do if your clothing or that of another student catches fire.

18. Know the location and correct use of the shop fire extinguisher.

19. Only use safety matches in school shops.

20. Do not light matches or use an open flame near containers of alcohol, gasoline, or other explosive fluids.

21. Never use any solvent with a flash point below 100°F, because of the danger of explosion and fire.

22. Keep rags that contain gasoline, alcohol, paint, varnish, kerosene, or other flammable liquids in self-closing, metal-covered receptacles to minimize the danger of spontaneous combustion.

23. Remember that there must be adequate ventilation where volatile or fume-emitting materials are used.

24. Be sure that the floor is clear of all obstructions. Good housekeeping helps to prevent slips and falls.

25. Wipe up spilled oil from the floor immediately. Otherwise, an accident may result.

26. Keep bench, cabinet, and locker drawers and doors closed when they are not in use. Passing students may be injured by an open door.

27. Do not leave tools and materials protruding from a vise or work bench. Passing students may be injured.

28. Remember that scraps or parts left on work benches and machines present a safety hazard.

29. Use a brush to clear away chips and a shop towel to clean oily areas. Do not use your hands or fingers.

30. Use proper storage facilities for stock and parts to avoid the danger of injury from loose pieces lying on the floor or bench.

31. Handle long pieces of material carefully so that they will not cause injury to other persons.

32. "Flag" projecting lengths of stock whenever they must extend beyond the end of a machine or bench.

33. Do not lift any objects heavier than you can handle easily. To pick up heavy objects, you should squat down and use the leg muscles to lift, keeping the back nearly vertical. This lifting procedure prevents serious injury.

34. Estimate the load. If it seems more than you can handle by yourself, ask for help.

35. In "team lifting," in which two or more students work together, let only one student call the signals while the team lifts together.

36. Always obtain assistance when you handle large sheets of metal.

37. When laying down heavy items, make sure that they will not tip nor fall against you or other persons.

38. Do not handle electrical equipment while you are standing on a wet or damp floor. Your body will be grounded, and serious shock or death may result.

39. Make certain that your hands are dry before you touch electric switches, cords, plugs, or equipment. Water is a conductor, and you could receive a shock or burn.

40. Be sure that worn or defective extension cords are replaced at once.

41. Remember that all portable electric tools should be properly grounded. This prevents electrical shock and usually is accompained by use of a three-conductor cable with a three-prong plug.

42. Do not blow with your mouth into blind holes or spaces to remove dust, dirt, and chips. Usually, particles will blow back into your face.

43. Obtain the approval of the teacher before using air hose.

44. Never point an air hose toward another person. Compressed air can drive small particles at high speed and can cause severe injury.

45. When using an air hose for cleaning parts, direct the air stream so that the dust and loose particles will not be blown into anyone's face.

46. Air may be used to clean equipment only when the area of use has been cleared of all students, the operator is wearing a face mask, and precautions have been taken so that flying chips, dust and dirt will not damage the equipment.

47. Do not lacerate your hands or fingers by carelessly sliding them over the edges of sheet metal. Sheet metal has razor-sharp edges, burrs, and "fish hooks."

48. Remove sharp burrs, corners, and edges from metal before working with it.

49. Place stakes in openings of the proper size; otherwise, the stakes may fall out and cause an accident.

50. Use baking soda water or weak ammonia solution to treat acid burns.

51. Keep your hands clear of the moveable parts of all hand-operated tools and equipment.

52. Do not wear rings when you are working in the shop.

53. Observe extra precautions in using steel wool to avoid getting steel dust and slivers into your eyes or hands.

54. Never use a half-opened stepladder. Make sure that the locking device, or the spreader to hold the ladder open, is fully set before stepping up.

55. Do not put nails, screws, tacks, or other small articles in your mouth.

56. Never carry several loose pieces of round stock at one time. Stock which has fallen to the floor may act as skids under your feet.

57. Wash your hands throughly, after using finishing materials.

58. Be courteous, considerate, and obliging at all times and under all circumstances.

59. Be ready to help when asked or when you observe someone in need of assistance.

60. Be sure that your teacher is aware of any physical condition or other handicap which may affect your performance in the shop.

## ELECTRIC POWER AND EQUIPMENT

61. Pupils should not touch electrical equipment with wet hands. Because sweaty or wet hands provide conduction for electrical current, the possibility of serious shock is increased. For the same reason, pupils should not make connections to electrical equipment while standing on a wet floor.

62. Complete the connections to any apparatus before plugging the cord into the power outlet. Always turn off the power before changing the connections on any equipment.

63. Keep fingers away from the live metal parts of the test leads.

64. Do not use cords with defective plugs or worn insulation.

65. Ground wires must be secured before tests are made.

66. Never work on wires that are carrying electrical current in a circuit.

67. The condition of the insulation on wire in high voltage circuits should be checked, and if it is necessary to change the wiring, insulated wire rated for the voltage should be used.

68. Pupils should never pull or replace fuses with their bare hands or with the power on.

69. Do not remove the amplifier dust pans or the grills while the current is applied to the amplifier.

70. Turn the power off before discharging the high voltage circuits before connecting equipment to the power source.

71. Be sure that interlock systems are in working condition. Never by-pass any safety interlock switches while working on electrical equipment.

72. Never replace resistors and condensers while current is on.

73. Connect clip leads to the high voltage circuits before connecting equipment to the power source.

74. The ground lead of a voltmeter must be securely grounded before the instrument is used.

75. Special care should be taken to see that the high tension leads of a power transformer are adequately insulated.

## ELECTRIC POWER AND EQUIPMENT (Continued)

76. All adjustments and connections to battery eliminators, power supplies, or transformers must be made before the power is turned on.

77. Experimental "breadboard" circuits must be checked by the teacher before the power is applied.

78. Insulation materials should be pot melted slowly. This operation should be performed under the direct supervision of the teacher. If the material catches fire, the flame should be smothered with a piece of sheet metal. The pot should not be lifted or carried from the furnace while the material is burning.

79. Any circuit or connection using 120 volts or more should be checked by the teacher before power is applied.

80. Use an isolation transformer with all AC and DC circuits.

## HAND TOOLS SAFETY

81. Be certain that hands remain free as possible of dirt, grease, and oil when using tools; keep tool handles free of them as well.

82. Use tin snips carefully and properly to prevent pinches and cuts.

83. File sharp edges carefully to avoid serious injury.

84. Hold chisels and punches with a firm grip, to minimize the danger of striking your hand.

85. Care should be taken when finishing hacksaw cuts to avoid sudden break through which might result in serious cuts or scratches.

86. Your fingers can be pinched painfully if you allow the handle of heavy vise to drop.

87. Attach vises securely to the work table or bench.

88. Do not hold small articles in the hand while tightening screws, assembling parts, cutting, prying, or performing similar activities.

89. Cut away from your body when using sharp-edged tools. If you are cutting toward yourself and the tool slips, it may cut into your hand, arm, or body.

## HAND TOOLS SAFETY (Continued)

90. Clamp small work on bench or secure in vise when using a gouge or wood chisel. Control chisels, gouges, and carving tools with one hand and supply power with the other.

91. Do not use chisels, punches, and hammers when the heads are mushroomed, burred, or battered.

92. Select a screwdriver blade of the proper size to fit the screw slot.

93. Select a wrench that fits the work properly. An improperly fitted wrench, may slip and cause skinned knuckles.

94. When threading do not spin the die stock to remove it; you may be hit by the spinning stock, or it may drop unexpectedly.

95. Pointed instruments and tools should be handled with care. Throwing them, dropping them, or placing them in pockets may cause accidents.

96. When carrying hand tools, always keep the points or cutting edges down and away from the body.

97. Use lever punches properly, to prevent pinched fingers.

## SAFETY COMMON TO ALL POWER MACHINES

98. Develop a respect for machines and an understanding of their purpose, what each is meant to do, what will happen if it is not used correctly, and how to care for it.

99. Learn to recognize the distinctive sound of a smooth-running power machine.

100. Recognize the unfamiliar sound caused by "crowding" or overloading, improper use, or worn parts. Never subject a machine to undue stress.

101. Obtain permission of the teacher before using any power machine or power equipment.

102. Be sure that all machines are at a dead stop while being oiled, cleaned, or adjusted.

103. Make sure that all guards are in place before starting a machine.

104. Be sure that all persons are clear of the machine before turning on the power.

## SAFETY COMMON TO ALL POWER MACHINES (Continued)

105. Safety zones painted on the floor must be respected. Observers must consider the zones as out of bounds, and remarks directed at the operator should be avoided.

106. The operator is the only one allowed in the safety zone while the machine is in operation.

107. Turn off the power when the job has been completed.

108. Notify the teacher when the machine is in need of repair, when the safety guard is missing or defective, or when further instructions are needed on the job.

109. Wear suitable clothes. Clothes should fit snugly. Anything, such as neckties, loose patch pockets, rings, earrings or gloves that can catch in machinery is prohibited. Keep sleeves rolled up.

110. Face shield or goggles must be worn by shop pupils when there is any possibility of eye injury. The teacher is responsible for designating shop activities and areas that are hazardous.

## BOX AND PAN BRAKE SAFETY

111. Keep fingers clear of the clamping bar and blade.

112. Be sure that observers are not standing near enough to be struck by counterbalance or the handles of the bending leaf when the brake is used.

113. Avoid overloading the machine by attempting to bend gauge beyond the capacity of the machine.

114. Before raising the bending leaf, keep all blade sections of the box and pan brake in line behind the bend line.

## POWER MACHINE SAFETY

### Motor Grinder and Buffing Wheel

115. Keep glass guards clean. Replace them when they become excessively pitted.

116. Do not use a tool rest on grinders equipped with a wire buffing wheel.

117. Report defective grinding wheels at once to the teacher.

Motor Grinding and Buffing Wheel (Continued)

119. Be sure that the grinding wheels fit the arbor and are tightened securely.

120. Do not exceed safe RPM limits for a grinding wheel.

121. Stand to one side while the grinding wheel is being faced or started. There is always a possibility that a wheel may break or that particles may fly.

122. Exercise caution when using the emery wheel dresser to dress a wheel.

123. Use light pressure when grinding.

124. Grind on the face of the wheel only, unless the wheel is designed for side grinding.

125. Do not hold a tool downward between the wheel and the rest while grinding. Dangerous jamming of the tool and wheel may result in injury.

126. Exercise care while holding work in the hands. Do not permit the work to slip and cause injury to the fingers.

127. Hold small pieces of material being ground with vise grips or a small vise to prevent the work from slipping and becoming jammed in the wheel. never use pliers.

128. Cover the exposed shaft end on grinders or buffers with an acorn nut or other suitable guard.

129. Hold material being ground or buffed at the proper angle and position so that it will not be torn from the hands.

130. Hold work with soft paper while buffing and grinding. If rags or waste are used, they may become caught and drag the work and hands into the wheel.

131. Do not allow hands to contact the grinding wheels and wire buffing wheel.

Drill Press

132. Remove chuck wrench from the chuck before turning on the power to prevent the chuck wrench from flying free and causing possible injury.

133. Chuck all drills on the shank only.

Drill Press (Continued)

134. Remove drifts immediately from drill press spindle after loosening taper-shanked tools.

135. Be sure that the drill is securely fastened in the center of the chuck before turning on the power.

136. While drilling small pieces of metal, hold in a drill press vise, or with a pair of pliers, or with some other suitable device. This procedure will protect the fingers in case the stock should catch and revolve with the drill.

137. Grip the vise firmly while drilling to prevent the drill from breaking or the work and vise from revolving in a manner which might cause injury.

138. Mount work or hold it on the drill press table in such a way that the work will not spring away.

139. Make sure that sheet metal being drilled is backed up by a scrap board and clamped to the table by means of a C-clamp.

140. Clamp large pieces of work securely to the drill press table before drilling.

141. Adjust the height of the drill press table before inserting a drill in the chuck.

142. Keep face away from the work being drilled to prevent injury to eyes or face should the drill break or hot oil or chips fly out.

143. Be sure that the drill does not pass through the stock and in to the drill vise or table. This would make them unsafe to hold work pieces.

144. Do not apply excessive pressure while drilling. Such pressure could cause the drill to break.

145. Lessen the feed pressure as the drill cuts through the work. This procedure will decrease the danger of the drill's catching the work and causing it to revolve.

146. Stop the machine immediately if the drill catches in a piece of work, causing it to revolve. It is dangerous to touch the work while it is in motion.

147. To prevent the hot, oily chips from being thrown against you, remove chips with a small brush while the machine is operating.

Drill Press (Continued)

148. Always use a sharp drill which has been ground for the material to be cut. Drills which have been improperly ground may dig into the work and possibly cause injury.

149. Operate the drill at the correct speed for the size of the drill and kind of material. If too much speed is used, or if the drill is forced too rapidly into the material, the drill will break.

150. Use suitable lubricants and coolants as required for effective drilling.

151. Set the drill press at slow speed when using the fly cutter.

Lathe

152. Remove the chuck wrench from the lathe chuck immediately after using the wrench.

153. Use chuck blocks or some other form of support while mounting or removing the chuck from the spindle, so as to keep the chuck from dropping on the fingers.

154. Do not use lathe power to put a chuck or face plate on a lathe spindle. Do this by hand.

155. Fasten all chucks and face plates securely to the spindle before turning on the power.

156. Do not suddenly reverse a lathe with a threaded spindle. The chuck or face plate may come off.

157. Be sure that all automatic feeds are in neutral position before turning on the power.

158. Run lathe through a complete cycle before turning on the power, to determine is there is proper clearance.

159. Secure work firmly in the chuck.

160. Stand out of line of a rapidly revolving chuck or face plate.

161. Counter-balance work on the face plate when the work is out of balance.

162. Stop the power feed before the tool reaches the jaws of the chuck.

Lathe (Continued)

163. Use caution while setting up the work between centers on a lathe. Before turning on the power, make certain that the tail stock is securely clamped to prevent the work from flying out.

164. Be sure that all necessary locking screws, bolts, and holders attached to or mounted on the carriage are securley clamped before turning on the power.

165. Regulate depth of cut according to size and type of metal. An incorrect adjustment may cause the metal to break.

166. Remove the cutting tools from the tool holder before taking the holder out of the tool post or performing other operations when the tool bit is not required.

167. Use tools that are properly ground for the particular job. Incorrectly sharpened tools may cause an accident.

168. Be sure the carriage has been moved next to the tailstock before doing any filing or polishing. This will prevent possible injury to hands or arms.

169. Use a file left-handed when filing on a lathe, so that the left arm will be protected from the chuck or face plate.

170. Do not handle the curling chips of metal while the lathe is in motion. The jagged edges of the metal chips may lacerate the fingers, or they may catch and draw the hand into the work. Use a brush to remove chips.

171. Do not attempt to polish work on the lathe by encircling it with a piece of emery cloth. This is a dangerous practice.

172. Tie a piece of cloth to the end of any piece of stock that extends through the headstock spindle. This will warn pupils who otherwise might accidentally walk against the revolving material.

173. Use caution when turning long, narrow bar material which extends beyond the end of the lathe. Support it in a manner that will prevent the material from whipping.

174. Avoid direct contact of hands with the work that is revolving in the lathe.

175. Use a micrometer only when lathe is stopped.

Lathe (Continued)

176. Perform all tapping operations in the lathe when the power is off.

## SQUARING SHEARS

177. Operate the machine alone. If two students are allowed to work on the shears, one might step on the treadle while the other has his foot in the way, or while he has his fingers under the knife.

178. Do not use the squaring shears to cut wire, rods, bars, or other stock. The shears are designed to cut sheet metal. Manufacturer's specifications should be followed as to the gauge of sheet metal that can be cut safely.

179. Apply foot pressure evenly on the treadle of the shears and with necessary force. Jumping on the treadle is dangerous.

180. Return the treadle slowly to normal position after finishing a cut. If the treadle is allowed to snap back, the treadle spring may fly off.

181. Be sure the foot is clear before pushing down on the treadle. When the shears cut through the metal, the treadle comes down to the floor with sufficient force to injure the foot seriously.

182. Operate squaring shears only from the front side.

183. Keep hands in front of the machine. Do not reach behind it. It is impossible to guard the knife at the back of the machine.

184. Allow metal stock cut by the squaring shears to drop to a table or the work area behind the shears. Attempting to catch the small pieces being cut off is dangerous.

185. Keep fingers away from the blade and all moving parts.

186. Be sure that pieces of sheet metal to be cut are large enough so that they can be held easily and securely.

187. Do not cut narrow strips of metal lengthwise. This cannot be done safely.

188. Cut only one thickness of sheet metal at a time.

## PORTABLE ELECTRIC DRILL

189. Exercise care while using the portable electric drill. See that the switch is in the "OFF" position when plugging the drill into an electric outlet. This will prevent accidents caused by the rotating drill.

190. Do not use the drill while standing on a wet or damp floor.

191. Make certain that the electric drill will not be turned on accidentally while the drill is being tightened in the chuck. Otherwise, it may become entangled in your clothing or cause injury. The switch should be in the "OFF" position.

192. Fasten the drill securely in the chuck and remove the chuck wrench before operating the drill.

193. Always operate the switch while holding the drill. Be ready to stop the drill instantly.

194. Keep face away from the drill motor handle. If the drill "grabs", the handle is likely to swing around, striking the face.

195. Hold the drill properly for the type of drill and the kind of job. Brace the body well to avoid being injured while using the heavy duty drills.

196. Exercise care when using an extension drill. Support it just above the flutes. This will keep the drill from whipping and breaking.

197. If necessary, fasten work properly so that it will not catch and revolve while the drill is in operation.

198. Be sure that the drill is sharp. Drills which are dull require excessive pressure and can cause accidents.

199. Apply straight and steady pressure on the drill.

200. Avoid excessive pressure while drilling, especially when the drill is nearly through the material.

201. Back drill out as soon as the hole is drilled.

202. Turn off power and hold the machine firmly until it comes to a dead stop; then rest the machine on its side.

203. Discontinue drilling if electric sparks jump from the point of the drill to the work. This may indicate an electrical grounding.

## PORTABLE ELECTRIC DRILL (Continued)

204. Disconnect electric cord after work is completed. Clean and return the machine to its designated place.

205. Use extension cords carefully. Arrange the lead wires directly from the wall plug to the floor to avoid hazard of slipping.

206. Prevent the cord from becoming entangled with the chuck and causing a shock or injury.

## SOLDERING AND WELDING

207. Place the soldering copper in the rack when it is not in use.

208. Soldering irons should be kept away from lacquered insulation. This type of insulation is flammable.

209. Do not perform any welding operations on a wet surface. Sputtering and exploding of molten metal may cause serious injury.

210. Do not inhale fumes of fluxes or cleaners.

211. Do not allow soldering fluxes to come in contact with the skin, eyes, or clothing, because they usually contain harmful chemicals.

212. Use caution in lighting the gas soldering furnace. Tilt the hood back and stand to one side.

213. Use care in handling heated metal. Hold firmly with pliers or tongs. Do not pick up metal from the bench with the fingers.

## PORTABLE SPOT WELDING

214. Wear a face shield or goggles for protection from flying sparks and molten metal.

215. Be sure that others nearby are protected from flying sparks.

216. Wear suitable leather gloves while operating a spot welder.

217. Prevent excessive explosion by proper preparation of work and correct set-up and operation of spot welder.

218. Do not rub fingers across completed spot welds. The welds may be hot or jagged.

## PORTABLE SPOT WELDING (Continued)

219. Prevent personal burns by not touching the work or the part of the machine that has become heated from the weld.

220. Shut off the spot welder as soon as all welding operations are completed.

221. Do not bring the electrodes together unless a piece of stock is between them.

## STORAGE BATTERY*

222. Check circuits for shorts before connecting battery.

223. Keep storage battery in a level position at all times. Place the battery where it will not slide or vibrate.

224. Verify that the lifting straps are secure before lifting battery. Use only approved carrying devices.

225. Check ability to carry battery before moving it from a support.

226. Check condition of battery posts before attaching lifting strap to them.

227. Wear approved clothing when handling batteries.

228. Use baking soda and water to neutralize any acid or battery electrolyte that may touch clothing or body.

229. Mix battery electrolyte in containers that will withstand heat and acids.

230. Pour acid into water.

231. Wash hands immediately after handling batteries.

232. Do not over fill a battery, especially if it is about to be charged.

233. Use the proper testers or test instruments to test batteries. Never use pliers on a wire.

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*This material has been included because many of the junior high school pupils will be operating automobiles within a short period of time after they complete this course.

234. Prevent arcing by connecting the battery cells together before the "load" is applied for charging.

235. Keep all flames and sparks away from a battery that is being charged. Flammable gases generated by a battery being charged may be ignited and cause an explosion.



JUL 21 1967